

## PATENT SPECIFICATION

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## (54) SPARK PLUG FOR AN INTERNAL COMBUSTION ENGINE

(71) We, ROBERT BOSCH GMBH, a German Company, of Postfach 50, 7 Stuttgart 1, Federal Republic of Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a spark plug for internal combustion engines, the plug being of a type comprising a central electrode with a platinum or part platinum ignition portion extending out of an insulator, an end face of the ignition portion being located opposite, parallel to, and at a distance from an earth electrode secured to the housing of the spark plug.

Many attempts have already been made to provide a spark plug for internal combustion engines which has adequate durability, a high degree of efficiency and which can be mass produced in a reliable and economic manner. Satisfactory access for the mixture of fuel vapour and air to the spark gap of the spark plug, and particularly reliable ignition of lean mixtures of fuel vapour and air, also count towards the functional efficiency of the spark plug.

In the most widely known spark plugs of this type, a platinum pin is used as the ignition portion of the central electrode. Owing to the relatively high demand for platinum, spark plugs of this type are relatively expensive and are also unsatisfactory since the method of securing the platinum pin is unreliable and, when the platinum pin has become detached from a spark plug, ignition no longer takes place in the relevant cylinder.

An object of the present invention is to provide a spark plug for internal combustion engines which has a high degree of functional efficiency, great durability, and which is substantially less expensive than a conventional spark plug having a platinum pin.

According to the present invention there is provided a spark plug for an internal

combustion engine, the plug comprising a housing, an earth electrode secured to the housing, a central electrode, and an insulator, the central electrode having a frusto-conical ignition portion extending out of the insulator and tapering to a platinum coated end face located opposite, parallel to, and at a distance from the earth electrode, the platinum coating having a thickness in the range of from 10 to 100  $\mu\text{m}$ . Preferably the platinum coating has a thickness of from 40 to 50  $\mu\text{m}$ . Advantageously substantially only the end face of the ignition portion of the central electrode is platinum coated.

In a preferred embodiment of the spark plug in accordance with the invention, the ignition portion has an end face having a diameter in the range of from 1.0 to 1.5 mm, and the frusto-conical ignition portion has a vertex angle of between 20° and 70°, preferably 45°.

The central electrode, coated with platinum on its end face on the ignition side, may be made from a nickel alloy or may be in the form of so-called two-component electrodes having a copper core and a nickel sheath, or may be made from a composite fibrous material surrounded by a nickel sheath. The free end of the earth electrode can extend fully across the end face of the central electrode, although, alternatively, it can be set back as far as the longitudinal axis of the central electrode.

The running limit of the spark plug, extended in the direction of leaner fuel vapour/air mixtures as a result of the frusto-conically tapering central electrode, can, in accordance with the invention be further extended in the direction of lean mixtures when the free end portion of the earth electrode tapers towards its end face, this end face having a width in the range of from 1.0 to 1.5 mm, and the vertex angle of the end portion being between 20° and 70°, preferably, however, 30°.

The invention will hereinafter be further described by way of example with reference to the drawings in which:

Fig. 1 shows a longitudinal section through the end portion, on the ignition side, of spark plug in accordance with the invention, drawn to an enlarged scale,

Fig. 2 shows a longitudinal section, taken on the line II/II, through that region of the spark plug shown in Fig. 1 (although the central electrode is not shown in section), and

Fig. 3 is a plan view of the free end portion of the earth electrode of the spark plug shown in Figs. 1 and 2.

The region of a spark plug in accordance with the invention which is illustrated in Figure 1 and 2 shows a portion of the housing 10 having the screw-in thread 11 and an earth electrode 12 which is welded at one end to the housing 10 and whose free end portion 13 is bent in a hook-shaped manner in front of the housing bore 14. A central electrode 15 extends coaxially within the housing bore 14 and is surrounded in a known manner by a ceramic insulator 16. The central electrode 15 is a so-called two-component electrode whose core 17 is made from copper and whose sheath 18 is made from a nickel alloy. The ignition portion 20 of the central electrode 15 which extends out of the end face 19 of the insulator 16 tapers in a frusto-conical manner towards its end face 21 and has a vertex angle  $\alpha$  of  $45^\circ$ . The central electrode 15 has a diameter of 2.3 mm, while the end face 21 of the ignition portion 20 has a diameter of 1.2 mm. The end face 21 is covered with a platinum coating 22 which is only  $45\text{ }\mu\text{m}$  thick, and which covers only 0.2 mm of the flank 23 of the ignition portion 20.

The end face 21 covered by the platinum coating 22 is located parallel to and opposite the free end portion 13 of the earth electrode 12 and is at a distance of 0.6 mm therefrom. The free end portion 13 of the earth electrode 12 overlies the end face 21 of the central electrode 15 and its end face 24 is at right angles to, and is aligned with an edge portion of, the end face 21 of the central electrode. In a preferred embodiment of the spark plug in accordance with the invention, and as is shown particularly clearly in Fig. 3, the free end portion 13 of the earth electrode 12 is constructed such that, with uniform thickness, it tapers towards its end face 24. The end face 24 has a width B of 1.2 mm, and the vertex angle  $\beta$  of the earth electrode 12 is  $30^\circ$ .

The spark plug illustrated in Figures 1, 2 and 3 requires certain modifications according to the use of such spark plugs constructed in accordance with the invention.

A central electrode made from nickel or a nickel alloy can be used instead of the

central electrode 15 which is illustrated and which has a copper core 17 and a nickel sheath 18, although, alternatively, it may be necessary to use a central electrode made from a fibrous composite material (fibrous composite materials comprise a matrix material having high electrical and thermal conductivity and in which are embedded corrosion-resistant fibres, for example, fibres containing nickel. This composite material may be surrounded by a sheath made from corrosion-resistant material).

The platinum coating 22 on the end face 21 of the central electrode can have a thickness in the range of from 10 to  $100\text{ }\mu\text{m}$ , preferably 40 to  $50\text{ }\mu\text{m}$ .

The end face 21 of the ignition portion 20 can have a diameter of from 1.0 to 1.5 mm, and the frusto-conical ignition portion 20 can have a vertex angle  $\alpha$  of between  $20^\circ$  and  $70^\circ$ , preferably  $45^\circ$ .

The earth electrode 12 may also require some modification according to its field of application:

The free end portion 13 of the earth electrode 12 can extend laterally up to 0.2 mm beyond the furthest portion of the edge of the end face 21 of the central electrode from the vertical portion of the earth electrode 12, although, if need be, it may be set back as far as the longitudinal axis of the central electrode 15.

The width B of the end face 24 may lie within a range of from 1.0 to 1.5 mm, and the vertex angle  $\beta$  of the end portion may lie between  $20^\circ$  and  $70^\circ$ , although, preferably, it is  $30^\circ$ .

#### WHAT WE CLAIM IS:—

1. A spark plug for an internal combustion engine, the plug comprising a housing, an earth electrode secured to the housing, a central electrode, and an insulator, the central electrode having a frusto-conical ignition portion extending out of the insulator and tapering to a platinum coated end face located opposite, parallel to, and at a distance from the earth electrode, the platinum coating having a thickness in the range of from 10 to  $100\text{ }\mu\text{m}$ .
2. A spark plug as claimed in claim 1 in which the platinum coating has a thickness in the range 40 to  $50\text{ }\mu\text{m}$ .
3. A spark plug as claimed in claim 1 or 2 in which substantially only the end face of the ignition portion of the central electrode is platinum coated.
4. A spark plug as claimed in any one of claims 1 to 3, in which the end face of the ignition portion of the central electrode has a diameter in the range of from 1.0 to 1.5 mm.
5. A spark plug as claimed in any preceding claim in which the frusto-conical

ignition portion of the central electrode has a vertex angle of between 20 and 70°.

6. A spark plug as claimed in claim 5 in which the vertex angle is 45°.

5 7. A spark plug as claimed in any preceding claim in which the central electrode is made from a nickel alloy.

8. A spark plug as claimed in any of claims 1 to 6 in which the central electrode has a copper core and a nickel sheath.

10 9. A spark plug as claimed in any of claims 1 to 6 in which the central electrode has a composite fibrous core surrounded by a nickel sheath.

15 10. A spark plug as claimed in any preceding claim in which the free end of the earth electrode extends fully across the end face of the central electrode.

20 11. A spark plug as claimed in any of claims 1 to 9 in which the free end of the earth electrode is set back as far as the longitudinal axis of the central electrode.

12. A spark plug as claimed in claim 10 or 11 in which the free end portion of the earth electrode tapers towards an end face of the free end, the end face having a width in the range of from 1.0 to 1.5 mm. 25

13. A spark plug as claimed in claim 12 in which the free end portion has a vertex angle in the range 20 to 70°. 30

14. A spark plug as claimed in claim 13 in which the vertex angle of the free end portion is 30°.

15. A spark plug substantially as hereinbefore particularly described with reference to and as illustrated in the accompanying drawings. 35

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Fig. 1

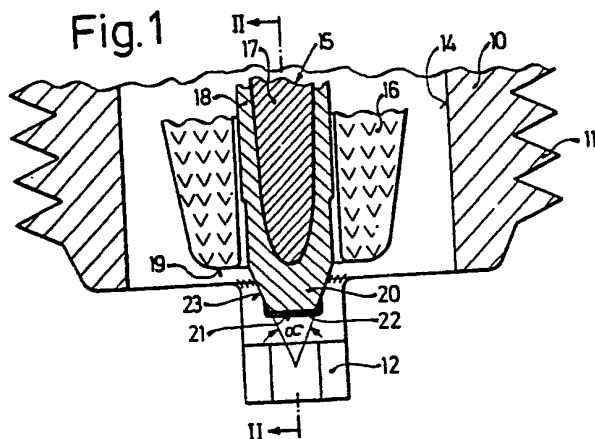


Fig. 2

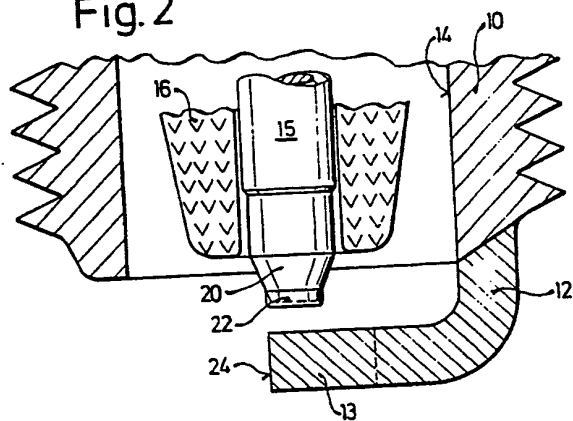


Fig. 3

